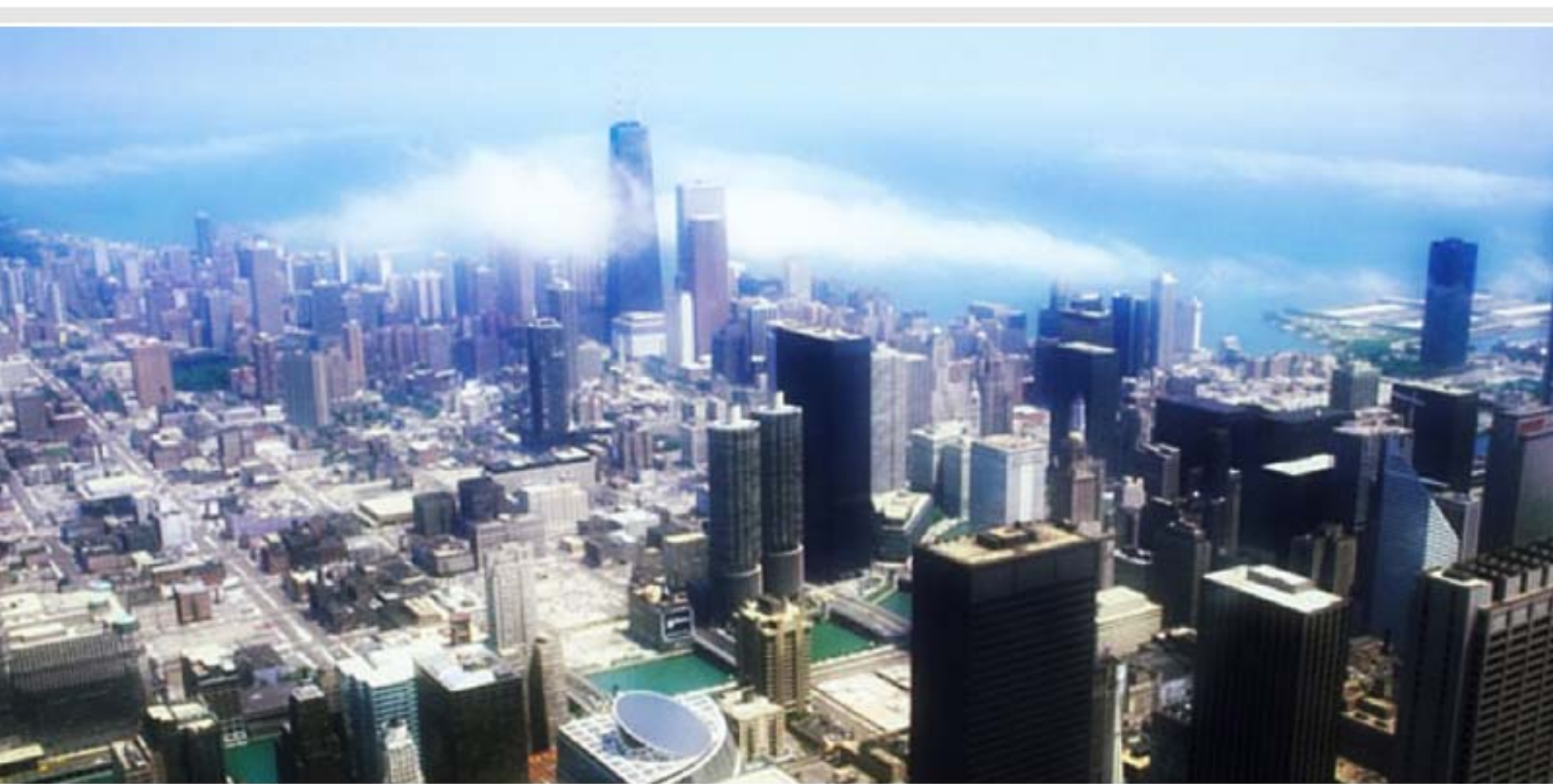


# Anthropogenic Chemicals in the Great Lakes Basin: Human Health Effects

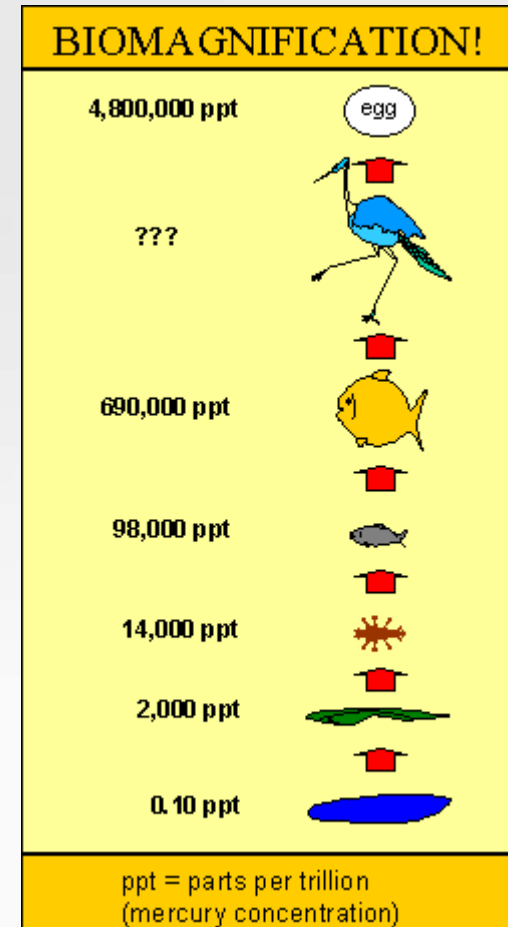
Daniel Hryhorczuk, MD, MPH



# Persistent Toxic Substances in the Great Lakes Basin



- Organochlorine compounds
  - PCBs
  - Hexachlorobenzene
  - DDT and metabolites
  - Dioxins and dibenzofurans
  - Mirex
  - Dieldrin
  - Toxaphene



# Persistent Toxic Substances in the Great Lakes Basin



- Heavy metals
  - Alkylated lead
  - Methylmercury
- Polycyclic aromatic hydrocarbons
- Emerging contaminants
  - Polybrominated diphenyl ethers (PBDEs)

# Key Findings



- Elevated body burdens of contaminants in persons who consume large amounts of Great Lakes fish
- Developmental deficits and neurologic problems in children of some fish-consuming parents
- Endocrine dysfunction among fish eaters
- Disturbances in reproductive parameters

# At Risk Populations from Contaminated Fish Consumption

- Native Americans and other indigenous peoples
- Sports anglers
- Subsistence fisherman
- Pregnant women, fetuses
- Nursing infants



# Human Health Studies:

## Fish consumption vs contaminant levels



- Michigan Sport Fisherman Study (Humphrey, 1976, 1983, 1988; Tee et al, 2003)
  - First demonstration of association between consumption of contaminated Great Lakes sport fish and serum levels of PCBs
  - Persons who annually consumed  $\geq 24$  lbs of fish had serum PCB levels 4x higher than controls
  - Monotonic decline in serum PCB levels among all participants from mean of 24 ppb in 1980 to 12 ppb in 1994 paralleled by and 83% decrease in fish consumption
- Wisconsin Fish Eater Study (Fiore et al, 1989)
  - Serum levels of PCBs and DDE statistically correlated with amount of Great Lakes fish consumed

# Human Health Studies:

## Fish consumption vs contaminant levels



- Great Lakes fish eaters, age 50 years and older (Schantz et al, 1996)
  - Those who consumed  $\geq 24$  lbs of sport fish for more than 15 years had higher levels of PCBs and 2x higher levels of DDE and mercury
- Great Lakes Consortium fish eaters (Turyk et al, 2005)
  - Blood samples from fish eaters obtained in 1993-95
  - Noncoplanar PCBs higher in fish eaters than in referent population, associated with fish consumption, and varied by lake

# Human Health Studies:

## Children's growth and development



- Michigan Maternal and Infant Study (Fein et al 1983, 1984; Jacobson et al, 1983, 1984, 1988)
  - Intrauterine exposures to diet of contaminated Lake Michigan sport fish (PCBs) associated with:
    - Decreases in infants birth weight
    - Decreases in gestational age
    - Decreases in head circumference
    - Infants exhibited neurodevelopmental and behavioral deficits on tests of visual recognition and memory at 7 months and 4 years of age
    - Poorer short- and long-term memory and lower IQ scores at 11 years of age

# Human Health Studies:

## Children's growth and development



- Newborns of Great Lakes fish eaters (Lonky et al, 1996)
  - Neurobehavioral deficits at 12-24 hours and 25-48 hours after birth from mothers who consumed on average 2.3 fish meals per month
- New York State Angler Cohort Study (Buck et al, 2003)
  - Absence of an adverse relation between Lake Ontario fish consumption and reduced birth size as measured by weight, length and head circumference
- Michigan Anglers Study (Karmaus and Zhu, 2004)
  - Maternal PCB concentration  $\geq 25$  mcg/l associated with reduced birth weight of offspring

# Human Health Effects:

## Endocrine disruption



- New York State Angler Cohort Study (Bloom M et al, 2003)
  - Hexachlorobenzene inversely associated with T4
- Great Lakes Consortium fish eaters study (Persky et al, 2001)
  - Serum PCB levels and fish consumption inversely associated with T4 and Free thyroxine index in women and T4 in men
  - Among men, there were significant inverse associations of both PCB and fish consumption with sex hormone-binding globulin (SHBG)-bound testosterone, but no association with SHBG or free testosterone

# Human Health Studies:

## Reproductive health



- New York State Angler Cohort Study (Mendola et al, 1997; Buck et al, 2000)
  - Consuming more than one fish meal per month associated with reduction in menstrual cycle length in women
  - Maternal consumption of fish for 3-6 years associated with reduced fecundability

# Human Health Studies

## Community Health Profile of Windsor



- Windsor AOC ranked among the highest of 17 AOCs on Canadian side of the Great Lakes for selected health end points potentially related to pollution
- Health outcomes data
  - Mortality
  - Hospitalizations
  - Congenital malformations
- Local industrial sources and transboundary air and water pollution from Detroit

Gilbertson and Brophy, EHP 109:827,2001

# Human Health Studies

## Fish consumption and breast cancer risk



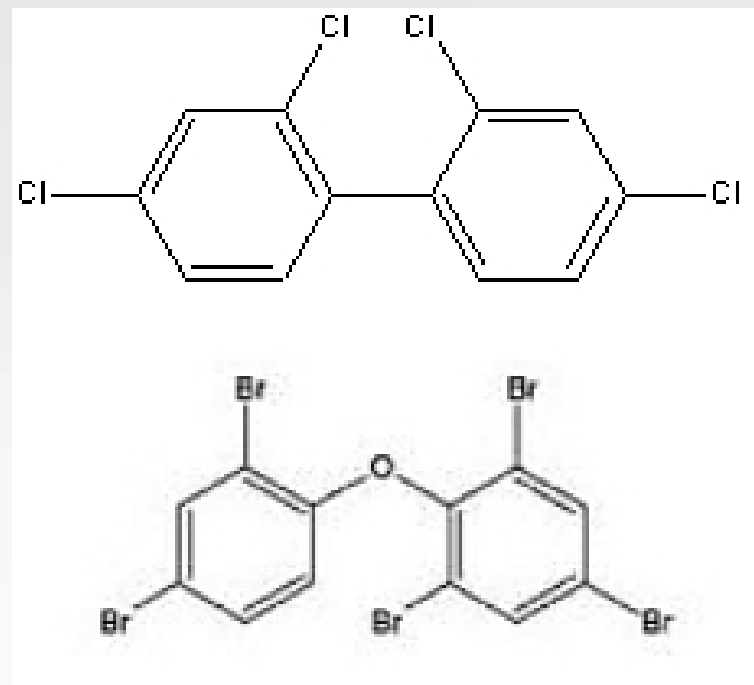
- Wisconsin population-based case control study
- Relative risk for recently consumed sport-caught fish
  - Overall: 1 (0.86-1.17)
  - Postmenopausal: 0.78 (0.57-1.07)
  - Premenopausal: 1.70 (1.16-2.50)
- Frequency of and location of consumption not associated with breast cancer risk

McElroy et al. EHP 112:156, 2004

# Emerging Pollutants



- While concentrations of most organochlorines in fish in the Great Lakes declined as first order decay from 1983-1999, the concentration of polybrominated diphenyl ethers (PBDEs) increased exponentially (Chernyak et al, 2005)
- PBDEs used as flame retardants
- Can bioconcentrate and bioaccumulate



# Emerging Pollutants



- Toxicologic effects of PBDEs
  - Thyroid hormone imbalance (reduction in T4)
  - Developmental neurotoxicity
  - Estrogen disruptors
  - Increased liver tumors

# Great Lakes Centers Environmental Profile of PCBs



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# Great Lakes Centers Environmental Profile of PCBs



**Environmental Profile of PCBs  
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